CLAIMS

1. A device for purifying exhaust gas for an engine having an exhaust passage, the engine being operated with a lean air-fuel ratio, the device comprising:

a SO_x storage arranged in the exhaust passage for temporarily storing SO_x contained in an exhaust gas inflowing therein;

an auxiliary catalyst arranged in the exhaust passage downstream of the SO_x storage, the auxiliary catalyst having an oxidizing ability;

SO_x discharging means for discharging SO_x stored in the SO_x storage therefrom; and

atmosphere control means for controlling an atmosphere of the auxiliary catalyst,

wherein, when SO_x stored in the SO_x storage is discharged therefrom with the atmosphere of the auxiliary catalyst being in a sulfate forming atmosphere in which an amount of a reducing agent contained in the exhaust gas flowing to the auxiliary catalyst is smaller than an allowable minimum amount and a temperature of the auxiliary catalyst is higher than an allowable maximum temperature, the atmosphere of the auxiliary catalyst is changed to an atmosphere other than the sulfate forming atmosphere, and when SO_x stored in the SO_x storage is discharged therefrom with the atmosphere of the auxiliary catalyst being in an atmosphere other than the sulfate forming atmosphere, the atmosphere of the auxiliary catalyst is maintained at an atmosphere other than the sulfate forming atmosphere.

2. A device according to claim 1, further comprising means for controlling the temperature of the auxiliary catalyst, wherein the temperature of the auxiliary catalyst is lowered to, or maintained at, a temperature which is not higher than the allowable maximum temperature, to change the atmosphere of the auxiliary catalyst to, or maintain the atmosphere of the

auxiliary catalyst at, an atmosphere other than the sulfate forming atmosphere.

3. A device according to claim 1, further comprising means for controlling an amount of the reducing agent contained in the exhaust gas flowing to the auxiliary catalyst, wherein the amount of the reducing agent is increased to, or maintained at an amount which is not smaller than the allowable minimum amount, to change the atmosphere of the auxiliary catalyst to, or maintain the atmosphere of the auxiliary catalyst at, an atmosphere other than the sulfate forming atmosphere.

4. A device according to claim 1, wherein the SO_x storage is carried on a particulate filter for collecting particulates contained in the inflowing exhaust gas.

5. A device according to claim 4, wherein, when SO_x stored in the SO_x storage is to be discharged therefrom, first, particulates collected in the particulate filter are oxidized while maintaining a temperature of the particulate filter at a temperature not lower than a particulate oxidation required temperature which is higher than the allowable maximum temperature, and then SO_x stored in the SO_x storage is discharged therefrom.

6. A device according to claim 5, wherein the atmosphere of the auxiliary catalyst is changed to an atmosphere other than the sulfate forming atmosphere when oxidation of particulates collected in the particulate filter is completed, and then discharge of SO_x stored in the SO_x storage therefrom is started.

7. A device according to claim 5, wherein the atmosphere of the auxiliary catalyst is changed to or maintained at an atmosphere other than the sulfate forming atmosphere at the end of oxidation of particulates collected in the particulate filter, and discharge of SO_x stored in the SO_x storage therefrom is started just after oxidation of particulates collected in

the particulate filter is completed.

8. A device according to claim 5, further comprising means for introducing at least a part of the exhaust gas to the auxiliary catalyst while bypassing the SO_x storage, wherein at least a part of the exhaust gas is introduced to the auxiliary catalyst while bypassing the SO_x storage, to change the atmosphere of the auxiliary catalyst to or maintain the atmosphere of the auxiliary catalyst at, an atmosphere other than the sulfate forming atmosphere.

9. A device according to claim 1, further comprising a bypass passage branching from the exhaust passage upstream of the SO_x storage at a branching portion and returning to the exhaust passage between the SO_x storage and the auxiliary catalyst, a switching valve for controlling an amount of the exhaust gas flowing through the bypass passage to control an amount of the exhaust gas flowing through the SO_x storage, and means for supplying a reducing agent arranged in the exhaust passage between the branching portion of the branch passage and the SO_x storage.

10. A device according to claim 9, further comprising means for switching a flow direction of the exhaust gas through the SO_x storage between a direction in which the exhaust gas enters into the SO_x storage via one end surface thereof and exits from the SO_x storage via the other end surface thereof, and an opposite direction in which the exhaust gas enters into the SO_x storage via the other end surface thereof and exits from the SO_x storage via one end surface thereof.

11. A device according to claim 1, wherein the temperature of the SO_x storage is maintained at a temperature not lower than a SO_x amount reduction required temperature which is higher than the allowable maximum temperature while an air-fuel ratio of the exhaust gas flowing to the SO_x storage is maintained at a rich or stoichiometric air-fuel ratio, to discharge SO_x

stored in the SO_x storage therefrom.

12. A device according to claim 1, wherein the SO_x discharging means comprises means for obtaining an amount of SO_x stored in the SO_x storage, and SO_x stored in the SO_x storage is discharged therefrom when the amount of SO_x stored in the SO_x storage is lager than an allowable SO_x amount.

13. A device according to claim 1, wherein the SO_x storage comprises a storage which stores SO_x contained in the inflowing exhaust gas in a form of sulfate salt.

14. A device according to claim 1, wherein the SO_x storage comprises a storage which stores SO_x contained in the inflowing exhaust gas without forming sulfate salt.

15. A device according to claim 1, wherein the SO_x storage comprises a NO_x catalyst which stores therein NO_x contained in the inflowing exhaust gas when the air-fuel ratio of the inflowing exhaust gas is lean, and reduces NO_x stored therein to reduce an amount of NO_x stored therein when a reducing agent is contained in the inflowing exhaust gas and the air-fuel ratio of the inflowing exhaust gas is lowered.

16. A device according to claim 1, wherein the auxiliary catalyst includes precious metals such as platinum without including alkali metals, alkali earth metals, and rare earth metals.

17. A device according to claim 1, wherein the auxiliary catalyst comprises a NO_x catalyst which stores therein NO_x contained in the inflowing exhaust gas when the air-fuel ratio of the inflowing exhaust gas is lean, and reducing NO_x stored therein to reduce an amount of NO_x stored therein when a reducing agent is contained in the inflowing exhaust gas and the air-fuel ratio of the inflowing exhaust gas is lowered.

18. A device for purifying exhaust gas for an engine having an exhaust passage, the engine being operated with a lean air-fuel ratio, the device comprising:

a SO_x storage arranged in the exhaust passage for temporarily storing SO_x contained in an exhaust gas inflowing therein;

an auxiliary catalyst arranged in the exhaust passage downstream of the SO_x storage, the auxiliary catalyst having an oxidizing ability; and

SO_x discharging means for discharging SO_x stored in the SO_x storage therefrom,

wherein discharge of SO_x stored in the SO_x storage therefrom is prevented or suppressed when the auxiliary catalyst is in, or is turned to, a sulfate forming atmosphere in which an amount of a reducing agent contained in the exhaust gas flowing to the auxiliary catalyst is smaller than an allowable minimum amount and a temperature of the auxiliary catalyst is higher than an allowable maximum temperature.

19. A device according to claim 18, further comprising atmosphere control means for controlling an atmosphere of the auxiliary catalyst, wherein, when the atmosphere of the auxiliary catalyst is in, or is turned to, the sulfate forming atmosphere, the atmosphere of the auxiliary catalyst is changed to an atmosphere other than the sulfate forming atmosphere and then SO_x stored in the SO_x storage is discharged therefrom, and when the atmosphere of the auxiliary catalyst is in, or is turned to, an atmosphere other than the sulfate forming atmosphere, SO_x stored in the SO_x storage is discharged therefrom while the atmosphere of the auxiliary catalyst is maintained at an atmosphere other than the sulfate forming atmosphere.

20. A device according to claim 19, further comprising means for controlling the temperature of the auxiliary catalyst, wherein the temperature of the auxiliary catalyst is lowered to, or maintained at, a temperature which is not higher than the allowable maximum temperature, to change the atmosphere of the auxiliary catalyst to, or maintain the atmosphere of the

auxiliary catalyst at, an atmosphere other than the sulfate forming atmosphere.

21. A device according to claim 19, further comprising means for controlling an amount of the reducing agent contained in the exhaust gas flowing to the auxiliary catalyst, wherein the amount of the reducing agent is increased to, or maintained at, an amount which is not smaller than the allowable minimum amount, to change the atmosphere of the auxiliary catalyst to, or maintain the atmosphere of the auxiliary catalyst at, an atmosphere other than the sulfate forming atmosphere.

22. A device according to claim 18, wherein the SO_x storage is carried on a particulate filter for collecting particulates contained in the inflowing exhaust gas.

23. A device according to claim 18, further comprising a bypass passage branching from the exhaust passage upstream of the SO_x storage at a branching portion and returning to the exhaust passage between the SO_x storage and the auxiliary catalyst, a switching valve for controlling an amount of the exhaust gas flowing through the bypass passage to control an amount of the exhaust gas flowing through the SO_x storage, and means for supplying a reducing agent arranged in the exhaust passage between the branching portion of the branch passage and the SO_x storage.

24. A device according to claim 23, further comprising means for switching a flow direction of the exhaust gas through the SO_x storage between a direction in which the exhaust gas enters into the SO_x storage via one end surface thereof and exits from the SO_x storage via the other end surface thereof, and an opposite direction in which the exhaust gas enters into the SO_x storage via the other end surface thereof and exits from the SO_x storage via one end surface thereof.

25. A device according to claim 18, wherein the temperature of the SO_x storage is maintained at a

temperature not lower than a SO_x amount reduction required temperature which is higher than the allowable maximum temperature while an air-fuel ratio of the exhaust gas flowing to the SO_x storage is maintained at a rich or stoichiometric air-fuel ratio, to discharge SO_x stored in the SO_x storage therefrom.

26. A device according to claim 25, further comprising means for introducing at least a part of the exhaust gas to the auxiliary catalyst while bypassing the SO_x storage, wherein at least a part of the exhaust gas is introduced to the auxiliary catalyst while bypassing the SO_x storage, to change the atmosphere of the auxiliary catalyst to an atmosphere other than the sulfate forming atmosphere.

27. A device according to claim 18, wherein the SO_x discharging means comprises means for obtaining an amount of SO_x stored in the SO_x storage, and SO_x stored in the SO_x storage is discharged therefrom when the amount of SO_x stored in the SO_x storage is lager than an allowable SO_x amount.

28. A device according to claim 18, wherein the SO_x storage comprises a storage which stores SO_x contained in the inflowing exhaust gas in a form of sulfate salt.

29. A device according to claim 18, wherein the SO_x storage comprises a storage which stores SO_x contained in the inflowing exhaust gas without forming sulfate salt.

30. A device according to claim 18, wherein the SO_x storage comprises a NO_x catalyst which stores therein NO_x contained in the inflowing exhaust gas when the air-fuel ratio of the inflowing exhaust gas is lean, and reduces NO_x stored therein to reduce an amount of NO_x stored therein when a reducing agent is contained in the inflowing exhaust gas and the air-fuel ratio of the inflowing exhaust gas is lowered.

31. A device according to claim 18, wherein the auxiliary catalyst includes precious metals such as platinum without including alkali metals, alkali earth

metals, and rare earth metals.

32. A device according to claim 18, wherein the auxiliary catalyst comprises a NO_x catalyst which stores therein NO_x contained in the inflowing exhaust gas when the air-fuel ratio of the inflowing exhaust gas is lean, and reducing NO_x stored therein to reduce an amount of NO_x stored therein when a reducing agent is contained in the inflowing exhaust gas and the air-fuel ratio of the inflowing exhaust gas is lowered.